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SOUND REPRODUCING SYSTEM

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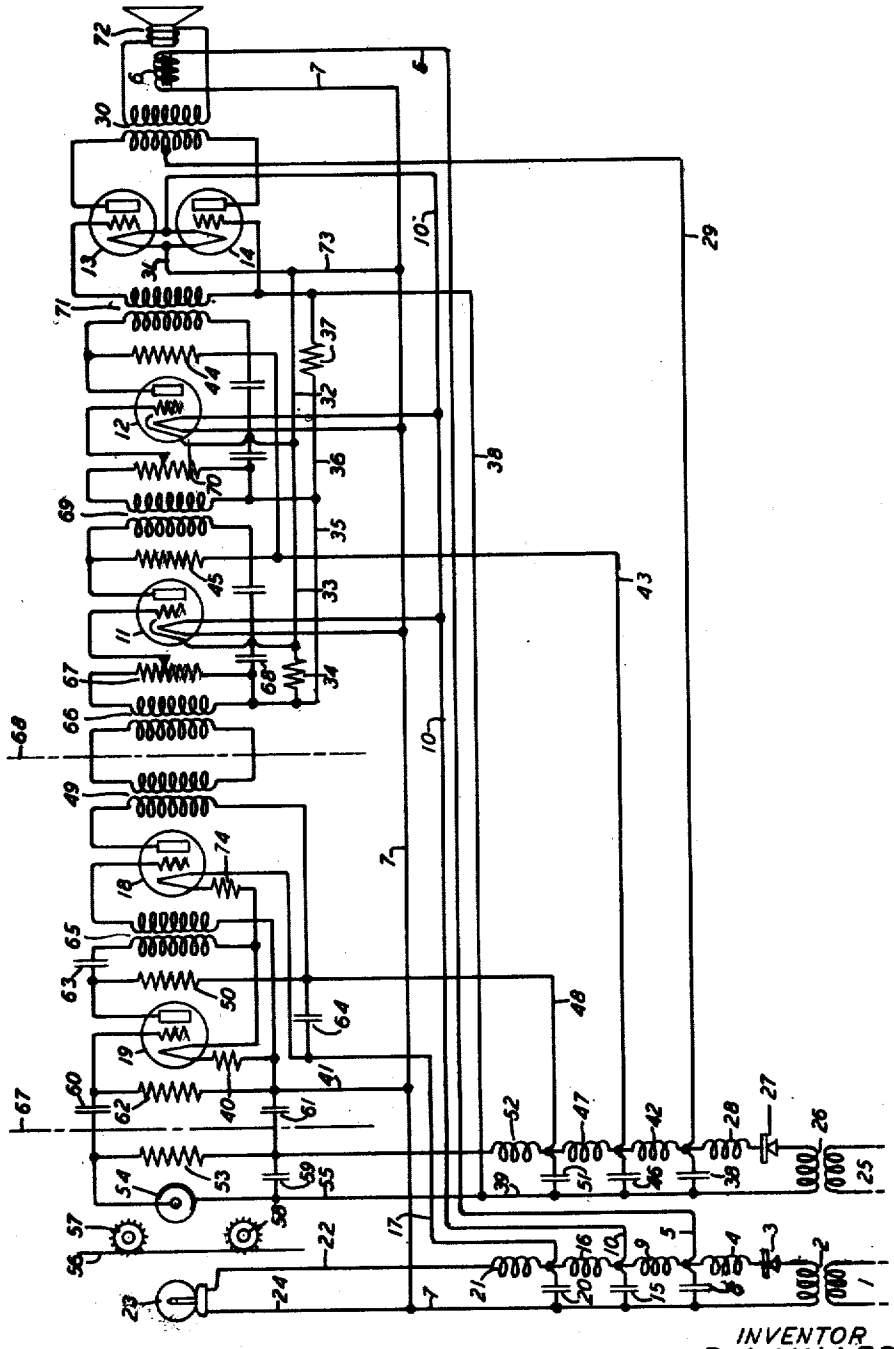

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SOUND REPRODUCING SYSTEM

Application filed September 23, 1930. Serial No. 483,957.

This invention relates to sound reproducing systems and more particularly to sound reproducing systems operated from an alternating current source.

Various types of sound reproducing systems such as known types of phonographs and radio sets have been operated from alternating current sources with reasonable success. Difficulty has been experienced, however, in operating on alternating current film sound reproducing equipments suitable for sound picture systems due to the very high amplification between the photoelectric cell and the sound radiator and the high quality of reproduction necessary.

Heretofore, known types of film sound reproducing systems have been mainly or entirely operated by direct current sources. Commercial types of direct current generators are not suited to service of this type due to the pronounced ripple produced in their output by the usual method of commutation which produces a steady hum in the reproduced sound. Special generators designed to overcome this difficulty are difficult to construct due to the small power and size required and have not proved an entire success. As a result, the direct current used in sound reproducing systems has been mainly supplied by storage batteries. The storage batteries required, however, are bulky, require skilled operation and maintenance and a separate current supply and apparatus for charging.

Owing to the disadvantages attending the use of storage batteries, many attempts have been made to replace the storage batteries with a source of supply derived from commercial alternating current circuits due to the constancy and reliability of these circuits and the ease with which the voltage may be transformed to any desired value. Rectified alternating current has been successfully used on the amplifiers feeding directly into the sound reproducers and has resulted in a system having economic and operating advantages over the use of storage batteries The use of rectified alternating current as a power supply for the other circuits in the reproducing system, has not heretofore proven commercially successful. Due to the very high amplification of the output of the photoelectric cell, it has been found that in known systems the ripple remaining due to incomplete rectification produces a hum in the output of the sound reproducer which is detrimental to the enjoyment of the sound. By using extreme precautions, it is possible to produce a supply of rectified alternating current which is practically as constant as the supply from the storage battery but the elaborate and complicated installation required has prevented these systems from becoming commercially successful.

In known systems of film sound reproduction, a certain amount of noise is produced by the sound radiator even during supposedly silent periods. This noise is caused by various irregularities in the system such as fluctuations in the output from the amplifiers, lack of cleanliness and uniformity in the sound record, and many others. The total volume of noise due to these causes is kept low enough that no disagreeable effect is produced on the listener. The volume of noise is generally near to or below the threshold of audibility of the listener. J. C. Steinberg has shown in his article "The relation between the loudness of a sound and its physical stimulus", the Physical Review, second series, vol. 26, October, 1925, that when the components of a complex sound near the threshold of audibility have values less than the values required for them to be audible when heard alone, they do not contribute to the loudness of the complex sound. In the present invention, the power supply is so arranged that the noise produced by variations in the supply is reduced to near the threshold of audibility and thus does not contribute to the loudness of the noise due to other causes. The total noise produced is thus not appreciably greater than the noise produced when the system is operated by storage batteries. At the same time, the system is so arranged that the irregularities in the power supply do not tend to cause a modulation of the sound frequency currents. It has been found that a system having the degree of imperfection in rectification lim-

ited as described above avoids the complications which have prevented the systems producing practically constant current from an alternating current source from becoming commercially successful.

The object of the invention is a film sound reproducing system operating on alternating current.

A feature of the invention is the use of rectified and filtered alternating current to supply the power required by the system.

Another feature of the invention is the reduction of the undesired noise due to operation on alternating current to a value less than the value of the undesired noise due to other causes in the system.

A further feature of the invention is a method of arranging the system so that the variations in the filtered current are prevented from producing a modulation of the sound frequencies.

The drawing represents in schematic form a film sound reproducing system embodying a preferred form of the invention.

Power from a commercial alternating current source is supplied to the primary winding 1 of the transformer 2 and the output of the transformer 2 is rectified in the rectifier 3 and flows through a choke coil 4. Part of the current flowing through the choke coil 4 is tapped off by wire 5 and flows through the field winding 6 of a sound reproducer of the dynamic type and back through wire 7 to the transformer 2. A shunt condenser 8 reduces the pulsations in the current supplied to the winding 6. The remaining current from the choke coil 4 flows through a second choke coil 9 and a part of this current is tapped off by the wire 10 and heats the filaments of vacuum tubes 11, 12, 13 and 14 returning to the transformer 2 through wires 31, 73 and the common wire 7. A shunt condenser 15 further reduces the pulsations in the current supplied to the filaments of vacuum tubes 11, 12, 13 and 14. The remaining current from the choke coil 9 flows through a third choke coil 16 and a part of this current is tapped off by the wire 17 and flows through the filament of vacuum tube 18, resistance 74, filament of vacuum tube 19 resistance 40 and wire 41 returning to the transformer 2 through the common wire 7. Another shunt condenser 20 further reduces the pulsations in the current supplied to the filaments of vacuum tubes 18 and 19. The remaining current from the choke coil 16 flows through a fourth choke coil 21, wire 22, filament of exciting lamp 23, wire 24, common wire 7 to transformer 2.

Power from a commercial alternating current source is also supplied to the primary winding 25 of a transformer 26 and the output of the transformer 26 is rectified in the rectifier 27 and flows through a choke coil 28. Part of the current flowing through the choke coil 28 is tapped off by the wire 29 and flows through the primary of the transformer 30 to the plates of the vacuum tubes 13 and 14, through the vacuum tubes 13 and 14 to their filaments, through wires 31, 32 and 33, resistance 34, wires 35 and 36, resistance 37 and wires 38 and 39 back to the transformer 26. A shunt condenser 38 reduces the pulsations in the current supplied to wire 29. The remaining current from the choke coil 28 flows through a second choke coil 42 and a part of this current flows through wire 43, and resistance 44 to the plate of vacuum tube 12, through vacuum tube 12 to wire 33. A parallel circuit from conductor 43 extends through resistance 45 to the plate of vacuum tube 11 and through vacuum tube 11 to wire 33. The combined plate currents of vacuum tubes 11 and 12 flow through resistance 34, wires 35 and 36, resistance 37, wires 38 and 39 to the transformer 26. A shunt condenser 46 reduces the pulsations in the current supplied to the plate circuits of vacuum tubes 11 and 12. The remaining current from choke coil 42 flows through choke coil 47 and a part of this current flows through wire 48 and the primary of transformer 49 to the plate of vacuum tube 18 and through the vacuum tube 18 and resistance 74 to the filament of vacuum tube 19. A parallel circuit from conductor 48 extends through resistance 50 to the plate of vacuum tube 19 and through vacuum tube 19 to its filament. The combined plate currents of vacuum tubes 18 and 19 flow through resistance 40, wires 41, 7, 73, 32 and 33 resistance 34, wires 35 and 36, resistance 37, wires 38 and 39 to the transformer 26. A shunt condenser 51 reduces the pulsations in the current supplied through the wire 48. The remaining current from the choke coil 47 flows through choke coil 52 and resistance 53 to the anode of the photoelectric cell 54, through the photoelectric cell 54, wires 55 and 39 to the transformer 26.

Light from the lamp 23 is directed on to a sound record on the film 56 by a suitable optical system (not shown) in a known manner. The film 56 is moved through the light at constant speed by the sprockets 57 and 58 which are rotated by mechanism (not shown) well known in the art. The modulated light which passes through the sound record excites the photoelectric cell 54 and causes a variation in the current flowing in the resistance 53. A condenser 59 provides a low impedance path for these fluctuating components of the current. The fluctuating voltages developed between the ends of the resistance 53 are applied through condensers 60 and 61 across the resistance 62. The grid of vacuum tube 19 is maintained negative with respect to its filament by the voltage drop in the resistance 40. The voltage applied across the resistance 62 varies the potential of the grid and causes a variation in the plate current of the tube

and an amplified voltage variation across the resistance 50. The voltage developed across the resistance 50 is applied through condensers 63 and 64 to the primary of the transformer 65. The voltage developed in the secondary of the transformer 65 varies the negative voltage applied to the grid of the vacuum tube 18 by the voltage drop in resistance 40, the filament of vacuum tube 19 and the resistance 39. The amplified output of the vacuum tube 18 is applied through the transformer 49 to a short transmission line leading to the input transformer 66 of a power amplifier. At the present time, two projectors are generally used in a sound picture installation and each projector will be provided wih an exciting lamp 23, photoelectric cell 54 and two-stage amplifiers 18 and 19. Only one power amplifier is essential so that the short transmission line between transformers 49 and 66 affords a convenient place to install means to switch the desired amplifier to the power amplifier. Shields indicated at 67 and 68 shielded the two-stage amplifier from external electrostatic and magnetic fields.

The output of transformer 66 is applied across a potentiometer resistance 67, and any desired portion of the voltage developed across the resistance 67 may be applied to the grid of vacuum tube 11. A condenser 68 affords a path of low impedance to the signal currents to the cathode of vacuum tube 11 and prevents the signal currents from flowing in resistance 34 and affecting the other vacuum tubes. The output of vacuum tube 11 is resistance coupled to a transformer 69. The output of transformer 69 is applied to the grid of vacuum tube 12 through a potentiometer 70 having a function similar to potentiometer 67. A negative bias is applied to the grids of vacuum tubes 11 and 12 by the voltage drop in the resistance 34. The output of vacuum tube 12 is resistance coupled to transformer 71. The output of transformer 71 is applied to the vacuum tubes 13 and 14 connected in push pull, where the signal is further amplified and supplied through transformer 30 to the moving coil 72 of the sound radiator. A negative bias is applied to the grids of vacuum tubes 13 and 14 by the voltage drop developed by the currents flowing in the resistances 34 and 37.

As was previously explained, the noise effects of the various parts of the system individually are maintained below certain limits, by means of proper filtering or "smoothing" of the rectified current supply to each element respectively. The total noise effect is thus held within such limits that the final sound ouput is of a high standard of quality.

What is claimed is:

1. A system for reproducing sound embodying, in combination, a source of illumination, a photoelectric cell, a photographic record of sound, means to cause said record to travel between said source and said cell, means for reproducing said sound controlled from said cell, a source of alternating current, a rectifier and a filter in the supply circuit for said source of illumination and operating from said source of alternating current, said filter being arranged to reduce variations in the current supply to said source of illumination to such an extent that the effect of said variations is less than the effect of variations in the remainder of the system.

2. In a sound reproducing system, in combination, a source of illumination, a photoelectric cell, a film having a photographic record of sound, means to cause said film to travel between said source and said cell, means controlled from said cell for reproducing said sound, a source of alternating current, a supply circuit for said source of illumination comprising a rectifier and a filter operated from said source of alternating current and arranged to reduce the variations in said alternating current to such value that the noise caused by said variations produces no perceptible increase in the noise produced by other irregularities in said system.

3. A method of reproducing sound embodying in combination a source of illumination, a photoelectric cell, a photographic record of sound, means to cause said record to travel between said source and said cell, means for reproducing said sound controlled from said cell, a source of alternating voltage, a rectifier and a filter operated from said source of alternating voltage to supply a polarizing potential to said cell and arranged to reduce the variations in said potential to such value that the noise produced by said variations causes no perceptible increase in the noise produced by other irregularities in said system.

4. In a sound reproducing system, in combination, a photoelectric cell, a lamp exciting said cell, a film having a photographic record of sound, means to cause said film to travel between said lamp and said cell, a thermionic amplifier controlled from said cell, a source of alternating current, a supply circuit for said lamp and the filaments of said amplifier operated from said source comprising a rectifier and a filter and arranged to reduce the variations in said alternating current to such value that the noise caused by said variations produces no perceptible increase in the noise produced by other irregularities in said system.

5. In a sound reproducing system, in combination, a photoelectric cell, a lamp exciting said cell, a film having a photographic record of sound, means to cause said film to travel between said lamp and said cell, a thermionic amplifier controlled from said cell, an electro-acoustic transducer operated by said am-

plifier and having an electromagnetic field, a source of alternating current, a supply circuit for said lamp, the filaments of said amplifier, and the field of said transducer operated from said source of alternating current comprising a rectifier and a filter arranged to reduce the variations in said alternating current to such value that the sound produced by said variations is not materially greater than the noise produced by irregularities in said sound record.

6. In a sound reproducing system, in combination, a photoelectric cell, a lamp exciting said cell, a photographic record of sound, means to cause said record to travel between said source and said cell, a thermionic amplifier controlled from said cell, a source of alternating voltage, a rectifier and a filter operated from said source of alternating voltage to supply a potential to said cell and the plate circuits of said amplifier and arranged to reduce the variations in said potential to such value that the noise produced by said variations is not materially greater than the noise produced by irregularities in said sound record.

7. In combination, an exciting lamp, a photographic sound record and a photoelectric cell for translating said record, a photoelectric cell amplifier, a loud speaker for rendering the translated sound record audible, a source of rectified alternating current for said exciting lamp and the field of said loud speaker, a source of rectified alternating current for said photoelectric cell and amplifier, a choke coil interposed in the circuit between said source and said photoelectric cell and amplifier and a main amplifier for the output of said photoelectric cell amplifier.

In witness whereof, I hereunto subscribe my name this 19th day of September, 1930.

ROBERT A. MILLER.

DISCLAIMER

1,871,383.—*Robert A. Miller*, Plainfield, N. J. SOUND REPRODUCING SYSTEM. Patent dated August 9, 1932. Disclaimer filed October 20, 1937, by the assignee, *Bell Telephone Laboratories, Incorporated.*

Hereby enters this disclaimer to claims 1, 2, 3, 6, and 7 of said Letters Patent.

[*Official Gazette November 9, 1937.*]

plifier and having an electromagnetic field, a source of alternating current, a supply circuit for said lamp, the filaments of said amplifier, and the field of said transducer operated from said source of alternating current comprising a rectifier and a filter arranged to reduce the variations in said alternating current to such value that the sound produced by said variations is not materially greater than the noise produced by irregularities in said sound record.

6. In a sound reproducing system, in combination, a photoelectric cell, a lamp exciting said cell, a photographic record of sound, means to cause said record to travel between said source and said cell, a thermionic amplifier controlled from said cell, a source of alternating voltage, a rectifier and a filter operated from said source of alternating voltage to supply a potential to said cell and the plate circuits of said amplifier and arranged to reduce the variations in said potential to such value that the noise produced by said variations is not materially greater than the noise produced by irregularities in said sound record.

7. In combination, an exciting lamp, a photographic sound record and a photoelectric cell for translating said record, a photoelectric cell amplifier, a loud speaker for rendering the translated sound record audible, a source of rectified alternating current for said exciting lamp and the field of said loud speaker, a source of rectified alternating current for said photoelectric cell and amplifier, a choke coil interposed in the circuit between said source and said photoelectric cell and amplifier and a main amplifier for the output of said photoelectric cell amplifier.

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